

§29. Development of Compact Divertor Plasma Simulator for Hot Laboratory

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Magnetically confined nuclear fusion research is now in new stage to produce D-T burning plasma toward DEMO and fusion reactor. Linear divertor plasma simulators (LDPS), generating high density plasma in steady state, have contributed so much to the basic understanding of SOL/divertor plasmas and plasma-wall interaction. Understanding of hydrogen isotope retention in plasma-facing materials is key to sustain long and/or steady state plasma in next generation fusion devices, such as ITER and DEMO.

Recently it has been revealed by Hatano *et al.* that hydrogen isotope retention in tungsten (W) increases dramatically due to irradiation defects introduced by neutron irradiation. Neutron irradiation creates uniform defects as a trap site in material, while ion beam irradiation mainly creates defects near material surface. It is necessary to study hydrogen isotope retention in neutron-irradiated materials under SOL relevant plasma condition.

In order to conduct plasma irradiation research with neutron-irradiated materials, new hot facilities having LDPS are planned and under construction in US and EU. These facilities can handle neutron-irradiated materials. However, in Japan, it is difficult to construct new hot facility having LDPS. Alternative strategy to study plasma-wall interaction of neutron-irradiated materials should be necessary.

International Research Center for Nuclear Material Science, Institute for Materials (IMR), Tohoku Univ. has a long history to conduct neutron irradiation tests using nuclear reactors overseas (BR2) as well as in Japan (JMTR, JOYO, JRR-3). Many neutron-irradiated samples already exist in IMR. We have developed a new LPDS with a dc plasma source composed of a zigzag-shaped LaB₆ cathode and a water-cooled hollow copper anode. The developed LDPS, being able to produce high density plasma more than 10^{19}m^{-3} in steady state, is more compact in size and can be installed in limited space of existing laboratories. We are planning to install the developed LPDS in a radiation-controlled area of IMR for the purpose to investigate the effect of neutron damage on the hydrogen retention characteristics.

The LPDS is connected to the existing thermal desorption spectroscopy (TDS) device as shown in Fig. 1. The sample carrier system is used to move the plasma-exposed samples from the vacuum chamber of the LPDS to the infrared heating equipment for TDS without

breaking vacuum. Fig. 2 shows a sample holder equipped in the LPDS. Neutron-irradiated sample ($\Phi 3.0\times 0.1$) can be mounted on the sample holder and the sample temperature can be controlled by air cooling within an accuracy of 5 K. The sample holder can release the mounted sample in vacuum.

Until the middle of 2014, we will finish constructing LPDS including the sample holder and the sample carrier system in Nagoya Univ. After that, the device will move to be installed in IMR, Tohoku University until the end of 2015.

We believe that this facility will become a new research platform for study of plasma-radioactive material interaction.

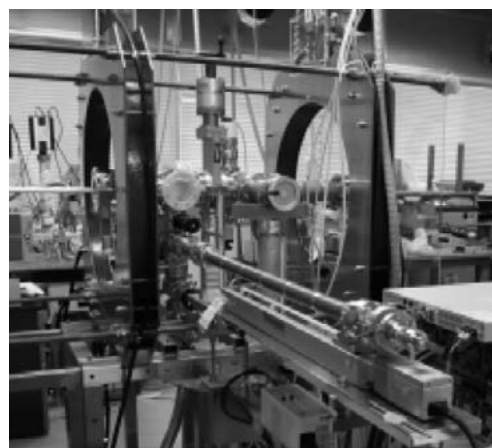


Fig. 1: Photo of the compact divertor plasma simulator with sample carrier system.

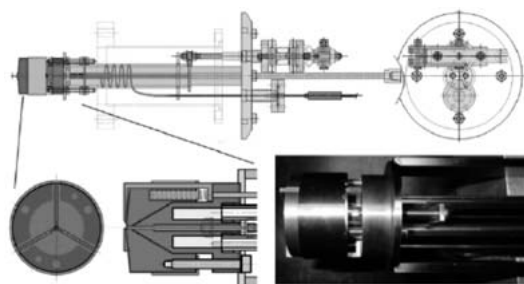


Fig. 2: Design of sample holder with air cooling.

The presentations and publications from this collaborative research are listed below:

- 1) N. Ohno, M. Takagi, S. Kajita, N. Matsunami, A. Sagara, M. Tokitani, H. Kurishita, T. Shikama, N. Yoshida, 4th Int. Workshop on Plasma Material Interaction Facilities for Fusion Research, 2013, Oak Ridge, USA.
- 2) H. Kurishita, M. Hatakeyama, M. Narui, S. Matuso, T. Shikama, N. Ohno, *et al.*, 23rd International Toki Conference (ITC-23), 2013, Toki, Japan, P1-59.